

NSG-275

SEMIANNUAL REPORT ON SPACE RESEARCH  
PROJECTS AT THE UNIVERSITY OF WISCONSIN

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## AERODYNAMIC PROBLEMS IN ROCKET ENGINES

### TAYLOR INSTABILITY AND DOUBLY-PERIODIC FLOWS IN VISCOELASTIC FLUIDS

R. B. Bird, Professor  
John D. Huppler, Professor  
Department of Chemical Engineering

This study is intended to be primarily an experimental evaluation of flow instabilities for viscoelastic fluids undergoing steady shear between rotating concentric cylinders. An attempt will be made to determine whether or not viscoelastic fluid characteristics have a stabilizing effect on the flow and to visually determine the nature of the flow instabilities.

A concentric cylinders apparatus suitable for the desired study has been obtained at no expense from Kimberly-Clark Corporation. Progress is being made in the cleanup, repair, and alteration of this equipment. A Weissenberg Rheogoniometer which is a valuable tool for characterizing fluids has been purchased. Considerable time has been spent setting up and calibrating this instrument.

A study of secondary flow patterns for the simple geometry of a close fitting disk rotating in a cylindrical tube has been undertaken. Results of this study are encouraging; the flow patterns are simple enough that there is some hope of describing them mathematically, and very different flow patterns are observed for Newtonian and viscoelastic fluids. This study will be pursued further by a Ph.D. candidate.

Further work that is planned is as follows. Calibration and adjustment of the rheogoniometer will be completed. Then several polymer solutions, which have already been characterized by other laboratories, will be tested in the rheogoniometer. Alteration of the concentric cylinders equipment will be completed.

The behavior of several aqueous polymer solutions in the concentric cylinders apparatus will be evaluated; the rheogoniometer will be used to characterize each fluid. An attempt will be made to determine which of the theoretical studies of rotational instability for viscoelastic fluids are in qualitative (or better, quantitative) agreement with the experimental results.

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### TRANSPORT PROPERTY MEASUREMENT OF HIGH TEMPERATURE GASES

H. N. Powell, Professor  
A. C. Berg, Professor  
R. Rangel, Professor  
Department of Mechanical Engineering

(I) Experimental developments.

(a) The shock tube test section reconstruction, underway at the beginning of the summer was completed in September. It was designed to permit (shock pressure) window loadings up to 500 psi. It has been tested to shock pressures of about 200 psi without breaking the vacuum seals around the windows. Other parts of the tube have been heavily reinforced.

(b) Tests of high pressure diaphragm materials and techniques for their accurate milling have been made with satisfactory results. Tests of the previously installed explosive charge diaphragm rupture mechanism were not satisfactory and lead to its redesign. The new mechanism functions satisfactorily.

(II) Analytical developments.

(a) A thermodynamic analysis of a new type of dynamically heated driver chamber has been completed by Mr. Rangel. He is now engaged in the heat transfer analysis. Mr. Rangel's M.S. thesis is to conduct a small scale model study of the proposed design.

(b) Considerable progress has been made in reducing the very complicated general shock perturbation equations developed in Mr. Berg's M.S. thesis to a practical form and reconciling them with previous work by Mr. Steenken. The immediate objective of this work is to arrive at the most promising test section wall configuration for shock perturbation.

(III) Work planned for the remainder of the fiscal year:

(a) Strong shock perturbation studies and preliminary attempts at transport property determination.

(b) Continuation of design and model studies for a new heated driver chamber.

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ION ACCELERATION AND PLASMA PROBLEMS

PROPAGATION OF ELECTROMAGNETIC WAVES  
IN SOLID STATE PLASMAS

R. N. Dexter, Professor  
Department of Physics

The NASA grant permitted us to purchase a Moseley Model 2D x-y recorder which has arrived and is in use. The recorder is primarily being used to record the interference patterns associated with the propagation of helicons (whistlers) in semiconductors (gray tin and InSb single crystals). We intend to continue such studies during the remainder of the fiscal year as we study electron and hole charge densities and effective masses by means of helicon propagation as a function of magnetic field.

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## MAGNETOHYDRODYNAMIC WAVE PROPAGATION

Roy M. Gunderson, Professor  
Department of Mathematics  
(UWM)

The following articles have been written:

1. "Thermally-driven nonlinear oscillations in one-dimensional magnetohydrodynamic flow". To appear in the International Journal of Engineering Science.

2. "The propagation of magnetohydrodynamic simple waves". Submitted to "Journal of Applied Mathematics and Physics" (Z.A.M.P.).

3. "Self-sustained thermally-driven nonlinear oscillations in one-dimensional magnetohydrodynamic flow". This paper is being typed.

At present, attention is being concentrated on two-dimensional steady magnetohydrodynamic flow.

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## A STUDY OF THE PROCESSES INVOLVED IN PLASMA ACCELERATION

Donald W. Kerst, Professor  
Department of Physics

The experiments on plasma clouds projected from a plasma gun are attempts to determine the distribution of the velocities and the densities of the particles in the cloud. So far the experiments have involved a particle energy analyzer into which particles from the cloud have been admitted. Determinations of energy can thus be made but there are many doubts about the interpretations of the energy distribution achieved and these doubts apply to most ion energy analyses that have been made in the past. We are trying to experimentally learn about the errors introduced when the plasma cloud strikes a culminating slit system for the energy analyzer. This is one of the major errors in such a system. The plasma cloud can stagnate, can produce sheaths with potential drops at the slit and can send ions into the energy analyzer which do not have the same energy that they had in the cloud. The experimental apparatus allows us to examine the angular dependence of the energy of particles which come through slits. Some observations have been made on this important point. If a thin shaft of plasma comes through the slit system, the angular dependence is due to spreading process involving electrostatic forces at the edge of the plasma. The first attempts at such observations revealed questions that must be settled about a plasma component, which seems to be impurity, which has an arrival time different from that of the hydrogen plasma. Spectroscopic with monochromator studies have shown the presence of carbon although the time of flight studies seemed to indicate boron which is present in the vacuum system glass. The kind of gun we are using is noted for its cleanliness but impurities are getting into the system somehow.

The problem of determining the distribution function and moving cloud of plasma or a shaft of plasma, has the difficulty that many separate questions seem to need to be answered simultaneously to make interpretations. Questions of whether or not plasma has impurities; whether or not the cloud of plasma coming from the gun to the detecting system at varying distances has within the cloud electrical and magnetic forces at work which change the distribution of velocities during the free flight of the cloud, all arise. For the solution to these and other questions we are trying to separate them one from another.

It was hoped that Dr. Jacquinet might be persuaded to continue longer in this country since in the previous year he carried the burden of setting-up much of the equipment. He would have been the post-doctorate fellow under the NASA program, but he had to return to France at the beginning of September. Consequently three of the assistants who worked with him previously and who know the apparatus are carrying on with a good start which he had given them and with some guidance from Professor Forsen early this fall and with my continued supervision. We still would prefer to associate a post doctorate physicist with this work, but we must do the work under any circumstances.

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#### MECHANICAL FUNCTIONING OF SPACE HARDWARE

##### STABILITY OF TRUNCATED HEMISPHERICAL SHELLS UNDER TENSION

Shun Cheng, Professor  
Department of Engineering Mechanics

We have investigated the available literature related to our problem and have found suitable nonlinear differential equations for stability of shells, and developed suitable numerical methods for the integration of the nonlinear equations that describe the finite deformations of these truncated shells.

In the remaining time of the fiscal year we plan to carry out the numerical computation and make further investigation of better numerical methods for solving such complicated nonlinear shell equations. Even though it seems that this project could not be completed within the limited time, we plan to continue this work and seek more support from NASA. We are of the opinion that continued research in this academically interesting and technologically important area will lead to significantly expanded and improved understanding of nonlinear stability problems.

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## EXPERIMENTS IN RANDOM VIBRATIONS

T. C. Huang, Professor  
Department of Engineering Mechanics

A M. B. Model C-10 Vibration Exciter System was delivered on November 11, 1965, and is now being installed. A research project in "Fatigue of Metals under Random Excitation" will be started as soon as the system is in operation.

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## NONLINEAR ELASTICITY

M. W. Johnson, Jr., Professor  
J. M. Kramer, Professor  
Department of Mechanics

We are reconsidering a problem that has been much investigated recently (1), (2), the buckling of thin spherical shell caps. The predicted theoretical buckling phenomena is a very complicated one and unexpected on physical grounds. Since we have reason to believe that the unusual results may be due (at least in part) to the severe approximations made in the equations we are re-computing some of the results with a more accurate model. We now have the equations in a form suitable for numerical treatment (see attachment. This proved to be more difficult than we had anticipated) and have written the necessary programs. We are about to begin some calculations.

What direction we go next depends on the results of these calculations. If the results are different than those of the simplified theory, we will do a great deal more calculation on this problem. We then wish to determine what is the cause of the difference because this may have important theoretical significance. If the results are not different, we plan to consider a different problem -- the development of numerical methods for non-symmetrical buckling problems.

- (1) H. F. Bueckner, M. W. Johnson, Jr., R. H. Moore, "The calculation of equilibrium states of elastic bodies by Newton's method", presented at the Ninth Midwest Mechanics Conference, August, 1965.
- (2) H. B. Keller, and A. W. Wolfe, "On the nonunique states and buckling mechanism of spherical shells", J. Soc. Indust. Appl. Math., 13 (1965), 674-705.

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## EXPERIMENTAL DETERMINATION OF THE MOMENT-CURVATURE RELATIONSHIP OF BEAMS SUBJECTED TO HIGH INTENSITY SHORT DURATION CYCLIC LOADS

William E. Saul, Professor  
Department of Civil Engineering

A graduate student has been selected to aid the principal investigator. Initial specimens are being machined. Major equipment for loading and mounting specimens has been located for use. Instrumentation for controlling the loading and sensing, measuring, monitoring and recording of output is partially procured with some pieces, not commercially available, being designed.

Since this endeavor is initial, the complete design of the experiment is required, and so the first tests will be trial efforts to aid in the complete experiment design. Details of final specimen shape, size and mounting; measurement of critical parameters and other requirements await, in part, the initial trials.

The plan of operations is to (1) test the initial specimens statically; (2) complete building the loading frame and hydraulic circuit; (3) check out the mounting system for stability and error control; (4) install and check the measuring transducers and recorder; (5) install and check the loading and control transducers (monitoring may be required in this and/or measuring systems); and (6) test. The schedule of operations, now that the ground has been laid and most major components located, will depend on the trial tests. Work was started on the project in September 1965.

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#### COMPUTER METHODS OF STRUCTURAL ANALYSIS

Chu-Kia Wang, Professor  
F. Y. Cheng, Professor  
Department of Civil Engineering

The High-speed digital computer has opened up vast possibilities in basic research for formulation of numerical methods in the analysis of large structural systems.

One project, "Stability of Rigid Frameworks Under Axial Loads", involves the search of a general computational procedure applicable to any complex rigid framework with geometric configuration, elastic properties of the constituent prismatic members, and primary axial forces as input. Method of attack involves the use of stability stiffness coefficients of prismatic members as internal functions in the computer program, the formulation of the stiffness matrix of the structure as a whole, and the search for stability factors which make the determinant of this matrix equal to zero by an iteration process.

Another project is "Free Vibrations of Rigid Frameworks". In this endeavor a general computational procedure is being sought to obtain the natural frequencies and modes of rigid frameworks with prismatic members, wherein these members are considered to be flexible as well as to have uniformly distributed mass. Successful attempts have been made in obtaining the detailed expressions for the dynamic flexibility and stiffness coefficients of prismatic members consistent with end rotations and end displacements.

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## SIMULATION OF SPACE ENVIRONMENT

### VACUUM TECHNIQUES PROGRAM

R. G. Herb, Professor  
Department of Physics

The work on vacuum techniques supported by NASA funds has led to improved understanding of the orbitron ionization gauge. Prospects now appear good for pushing the x-ray limit a factor of 10 below the Bayard Alpert Gauge.

In orbitron pumping our work has led to improved understanding of the role of methane in determining ultimate pressure. Equipment has been built up for study of the generation of other gases at surfaces due to electron bombardment.

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### VACUUM PHYSICS RESEARCH

William L. Walters, Professor  
Department of Physics  
(UWM)

Modification of an existing vacuum system is nearly complete. Additional valving and plumbing has been added so that two separate ion pumps can be used, either simultaneously or separately. A tandem pump arrangement is needed because we anticipate conditions which will make self-sustained pumping in our Orbitrons impossible. These modifications have been of a routine nature. So far only hourly workers have been involved. One graduate student will join the project on December 3 after he takes the written master's degree exam. We expect to be operational by Christmas.

Helium will be passed through a permeation leak-gas purifier and pumped in the experimental chamber over an extended period of time. About 10 cm<sup>2</sup> of the chamber wall will constitute the studied surface. After prolonged adsorption and presumably, diffusion of helium this surface will be heated and the temperature dependence of released helium will be noted by a partial pressure analyzer looking directly at the surface.

An attempt will be made to extend the work to other gas - metal systems. Another vacuum chamber and a second gas handling system are needed if this is to be begun before the helium work is finished.

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## SPACE COMMUNICATIONS

### FORWARD ADAPTIVE COMMUNICATION SYSTEMS

W. P. Birkemeier, Professor  
Department of Electrical Engineering

This proposal concerns the transmission of information at high rates over radio links of several hundred miles such as found in satellite-to-airplane paths. Our interest originates from our research of the past two years in radio-meteorology using the forward-scatter of microwaves in the lower atmosphere as a meteorological probe. By applying statistical analysis to the phase as well as the amplitude of received signals transmitted beyond the horizon we have discovered mechanisms which can account for the multipath nature of the radio channel and which we feel will lead to meaningful measures of the time-variable parameters of coherent bandwidth and information capacity. In an effort to find ways to use radio scatter-links more efficiently for information transmission it became apparent to us that the transmitter should be matched to the channel, i.e. transmit a signal which at all times matches the channel's ability to convey it. Such a system, involving feedback from the receiver to the transmitter has been developed in our group. In this system the changing channel characteristic is measured continuously by a wide-band sounding signal. Simultaneously an information signal may also be transmitted on the channel. These signals, while occupying the same general RF frequency band are orthogonal and thus separate at the receiver. Recovery of the sounding signal leads to a set of instructions to be relayed on a return radio link to the transmitter. Since the return information concerns the inherently slow variations in the channel, the bit rate is low and can be interpreted by the transmitter with negligible error. The question of what the transmitter can or should do with knowledge of the channel is what we wish to answer by the proposed research. Various possibilities exist such as adjusting the center frequency, the bandwidth, or the modulation modem.

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### ECONOMIC IMPLICATIONS OF U. S. COMMUNICATIONS SATELLITE POLICY

Edward J. Heiden, Professor  
Department of Economics

Thus far my project has been concerned with the question of an optimum pattern of rate regulations for communication satellites (comsats), which will be engaged in providing international telephone, telegraph, and data transmission services.

A model of optimum regulatory level and structure of rates has been set forth. The problems of implementing both the structure and level optimum in terms of estimated actual rates and costs that should

be charged is now being studied on various assumptions of satellite coverage and technology. This phase of the study is approximately 2/3 complete. Tentative conclusions are that there is an optimum time path of downward rate adjustments called for in the case of satellite service, and this has been specified carefully for all regions satellites will serve. This optimum rate level as well as the path and rate of downward adjustment differs for different regions served. These differences have been derived by making assumptions about international flows of messages as well as their rates of growth. Economic and non-economic institutional barriers to an optimum rate policy are now being studied and described to accompany the empirical implementation of the optimum.

The remainder of the study will be concerned with the possible effect of comsat on competition in the U.S. domestic communications industry. I will be in Washington the rest of this week gathering data and estimates on comsat's future market and cost potential for domestic communications. While there I hope to talk to relevant officials involved in the problem of domestic comsat regulation also. My purpose for the second half of this project is to give concrete evidence for the regulatory problems involved in seeing that comsat technology fully benefits the public as well as investors in communications technology in general. Most of these regulatory problems stem from the fact that comsat will have enormous implications for existing (competitive) communications technologies. I want to point up the regulatory problems involved, by specifying those competitive implications.

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#### PROGRAMMING DEVELOPMENT SUPPORT RELATED TO SPACE SCIENCE ACTIVITIES

Mervin E. Muller, Director  
Computing Center

Progress during this period consisted of specifying the initial functional capabilities of the program, preliminary specification of the method of User communication with the program, and description of the manner in which the program will provide feedback to the User. The program is expected to include capabilities for checking the validity of data, maintaining files, selection and retrieval of data from files, re-formatting and conversion of data, and sorting and merging files. User communication to the program is expected to be in the form of English based specification statements which are used to describe the structure and format at the input file, operations which are to be performed, and the structure and format of the output file. The program is expected to make a thorough evaluation of the User's statements to ensure the validity of individual statements and consistency between statements. Any errors which are discovered will be reported to the User and the point at which the error occurred will be shown.

Plans for the next period are the development of: 1) a complete set of English based specification statements for User control of the program, 2) a detailed design of the program, and 3) a plan for a

"building-block" implementation of the program to provide for maximum flexibility in the modification of capabilities and incorporation of additional capabilities as they are needed.

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#### SPACE MEDICINE AND MAN'S BEHAVIOR IN SPACE

##### SEQUENTIAL EFFECTS OF PSYCHOLOGICAL JUDGMENTS

Robert Calfee, Professor  
Department of Psychology

Three studies are now underway as part of this grant. The first study is concerned with the effects of visual field size and exposure duration on the detection of the number of objects in a field. Data from two subjects are now available, and additional subjects are going to be run under slightly changed conditions to get a closer look at the detection rate with very short exposures.

The second and third studies are concerned more directly with the question of sequential effects in psychophysical judgments. Apparatus construction and checkout has recently been completed for these studies, and experimental subjects will be run beginning next semester. The second study will investigate effects of context and of standard values on the perception of direction of a visual flash with minimal cues. The third study is designed to determine, in a standard auditory two-interval forced-choice signal detection task, whether detection rate is affected by payoff value, when the latter is varied within a single experimental hour for a single subject.

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#### MEASUREMENT OF BONE MINERAL IN LIVING SUBJECTS

John R. Cameron, Professor  
Departments of Radiology and Physics

Mr. Robert Witt, a graduate student in Physics, is working on the problem of Quantitative Measurement of Bone Mineral in Living Subjects. In connection with his earlier research, he has programmed the University CDC-1604 computer to do the calculations on data obtained from studies of living subjects. This has permitted the reduction of human labor from approximately 45 minutes per subject studied to less than five minutes. This will permit us to do a great number of individuals in order to evaluate the variations of bone mineral from one bone to another and from one body type to another. During the second half of the fiscal year it is planned to measure as many different individuals as possible and at different times, in order to evaluate any changes, and also to evaluate our technique in a variety of situations.

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## PHYSIOLOGY OF ANXIETY

J. J. Chosy, Professor  
D. T. Graham, Professor  
Department of Medicine

Questionnaires designed to estimate the body harm and separation subdivisions of anxiety were given to approximately 4500 freshman students. The questionnaires have been tabulated and are being used to make up a pool of experimental subjects.

An experiment designed to examine the effect of induction of hypnosis on urine catecholamine excretion has been completed. The urine chemistries are not completed.

A second study is underway in which psychiatry out-patient clinic patients are being given a battery of anxiety questionnaires. The answers will be correlated with urine catecholamine and corticosteroid excretion rates.

In the next six months we plan to measure intra-arterial blood pressure and heart rate responses in hypnotized patients who are given suggestions intended to induce body harm and separation anxiety. We hope to extend this study with urine and blood catecholamine measurements as well.

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MECHANISM OF PARATHYROID HORMONE ACTION WITH SPECIAL EMPHASIS  
ON THE ROLE OF HORMONE IN THE TRANSFER OF CALCIUM,  
PHOSPHATE, MAGNESIUM, POTASSIUM AND SULFATE IONS ACROSS  
SUBCELLULAR MEMBRANES

H. F. DeLuca, Professor  
Department of Biochemistry

Work on the specificity of parathyroid hormone induced translocation of inorganic phosphate and other ions into mitochondria has received considerable attention in the past few months. Of great importance to a continuation of an examination of these mitochondrial systems is whether the reactions observed are unique and specific for the hormone. The value of the mitochondrial system, of course, relies heavily upon the assumption that it is a valid model of hormone action. Work therefore is continuing on the purification of the hormone aiming ultimately at obtaining a single peptide. In work performed in the past few months, a greatly improved purification procedure has been devised which results in greatly purified parathyroid hormone superior to that thus far reported. However, in its highly purified state the parathyroid hormone is quite unstable. This instability has frustrated further attempts to obtain a single peptide. Consequently, methods of stabilizing the pure hormone are now under study and following the solution of this problem it seems almost certain that we will be able to obtain a single peptide and examine the question of whether the mitochondrial response is in fact due to the parathyroid polypeptide.

The highly purified parathyroid hormone nevertheless stimulates magnesium phosphate transport into mitochondria. No evidence that it affects sodium or potassium transport could be obtained.

Although another parathyroid peptide which is not hormone as well as protamine could mimic the hormone's action on mitochondria, the effects of these agents on the mitochondria could not be eliminated by peracetic acid oxidation while those of the hormone could be eliminated completely by this procedure. It is well known that peracetic acid oxidation eliminates all physiologic effects of the hormone thereby providing further proof of parathyroid hormone specificity in the mitochondrial system.

An apparatus which can be used to measure the immediate effects of parathyroid hormone on mitochondria is now under construction. A sodium and a potassium sensitive electrode has already been obtained and a phosphate electrode is expected momentarily. Upon completion of this apparatus which measures sodium, potassium, phosphate ion movements, swelling of mitochondria and oxygen consumption, it will be possible to carry out experiments to determine the early sequence of events which take place when parathyroid hormone is added to isolated mitochondria.

It has been shown in other experiments that parathyroid hormone inhibits energy dependent reduction of NAD by succinate whether the energy is provided by respiration or ATP. In a reverse fashion energy linked reduction of NAD inhibits parathyroid hormone induced transport of magnesium phosphate demonstrating that these systems are mutually

competitive. Work is continuing on the interaction of the hormonal system with the other energy linked processes of mitochondria. It is hoped ultimately that these systems may well aid in the isolation of the parathyroid hormone dependent transport system from mitochondria.

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#### ENVIRONMENTAL FACTORS AFFECTING DRUG METABOLISM

K. F. Finger, Professor  
School of Pharmacy

The experimentation conducted to date includes: (1) Effect of hypothermia on extent and duration of action of chlorpromazine induced bradycardia and hypotension, (2) Effect of various stress inducing conditions on duration of pentobarbital induced hypnosis (sleep) and (3) Effect of various stress inducing conditions on rate of enzymatic hydrolysis of esters.

- (1) Hypothermia has been shown to produce a dramatic alteration in the extent and duration of chlorpromazine's action in the rat. Utilizing the chlorpromazine induced bradycardia as one index, the lowering of the body temperature from a normal of 36-38° C to 29-39° C resulted in a 250% increase in the duration of this effect. This increased duration of action is presently thought to be the result of a decreased rate of metabolism of chlorpromazine caused by the lowered body temperature. A report of this study has been submitted for publication. At the present time we are isolating and identifying the various metabolites of chlorpromazine from biological tissues in an attempt to correlate the observed alterations in duration of action with either the rate or the route of drug metabolism.
- (2) Utilizing centrifugal force (18 X g), cold exposure (5° C) and chemical irritation (Formalin, subcutaneous) as forms of stress, the sleeping times of rats treated with pentobarbital were determined before and after stressing. We have observed marked prolongation of sleeping times resulting from exposure to cold environments and no change in sleeping times resulting from high centrifugal force exposure or from chemical irritation. We are attempting to correlate the above results with the changes in drug metabolizing enzyme activity.
- (3) The above stress conditions produced no change in the activity of liver esterases in adult animals. At the present time we are investigating the effect of cold stress in young and weanling rats.

In summary, various environmental conditions have been shown to produce an alteration in the extent and duration of action of certain drugs and attempts are being made to correlate these changes with changes in the activity of drug metabolizing enzymes.

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#### LEARNED RESPONSES WITH INCONGRUOUS STIMULI

David A. Grant, Professor  
Department of Psychology

Three parallel experiments on "correct" and "incorrect" arithmetic problems and sentences have been completed, two involving tachistoscopic speed of recognition of correctness and incorrectness and one on conditioned discrimination of correct and incorrect arithmetic. In the last, aversive or unpleasant reinforcement turns out to be less effective when applied to "correct" problems than when applied to "incorrect" problems. This CS-UCS incongruity effect is a novel finding that the Soviet investigators seem to have missed in their research on related problems.

Currently ongoing experimentation parallels the arithmetic problem differential conditioning with sentences in one experiment, and extending the arithmetic conditioning to instrumental as opposed to classical conditioning, so that a pleasant or rewarding UCS or reinforcement is being used instead of the aversive UCS of the earlier experiment. This will enable us to see if we can reverse the results of the earlier experiment when we reverse the pleasantness of the reinforcer--which should be the case if CS-UCS incongruity is the basis of the earlier result.

Further work is being instrumented and planned, recording the orienting reflexes that we believe may underlie the apparent disinhibition produced by internally incongruous conditioned stimuli. This work will vary from simply tracing the habituation of the reflex to congruent and incongruous stimuli to introducing incongruity in various conditioning experiments where the OR and the conditioned eyelid reflex are simultaneously recorded.

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#### INTRAVASCULAR ALTERATIONS SECONDARY TO LOW OXYGEN SIMULATED ATMOSPHERES

Enrique Valdivia, Professor  
Department of Pathology

The following items are being studied:

- (1) Fatty change of the granular pneumocyte.

Guinea pigs exposed to severe hypoxia in low pressure chambers develop fat vacuoles in the granular pneumocytes. The osmiophilic lamellar bodies are apparently reduced in size and decreased in number. Hypoxic lipophanerosis of the granular pneumocyte may represent a metabolic alteration and interfere with the production of surfactant. This hypoxic lesion of the pneumocyte may be a pathogenic factor in high altitude pulmonary insufficiency.

Accepted for publication. Science.

- (2) The work on an artificial perfusion system simulating pulmonary circulation is in progress. The perfusion pressure of guinea pig red blood cells is being studied. The experiments are designed to obtain values of perfusion pressure of blood with hematocrits between 40 and 80%.

- (3) The Elron Fragiligraph is being used to determine osmotic fragility of red blood cells in control and polycythemic guinea pigs.

- (4) Deer mice specimens from sea level (6), native to high altitude (4), and adapted to high altitude (8) have been collected in collaboration with Dr. R. E. Smith, Department of Physiology, U.C.L.A. and the Bancroft high altitude Laboratory of the University of California.

This material is being studied with the Electron Microscope.

Subject: Additional Support.

The polycythemic blood of hypoxic animals has been studied with the Coulter Counter model B. This apparatus plots the size of red blood cells in a diluted isotonic solution. Approximately 400 determinations have been performed to date. These results indicate that determinations should be done immediately after bleeding the animal and diluting the blood. The available apparatus has an electronic gate of 100 microns. This instrument belongs to the Department of Obstetrics. Accurate sizing of guinea pig red blood cells will require smaller aperture gates available in the Coulter Counter and the immediate use of this instrument. The current price of the complete unit is \$8,000. We have no funds available to purchase this unit.

Salaries:

A senior research assistant in our laboratory was planning to leave with her graduating husband but now plans have changed and we have no support for her for the second half of the current academic year (January to June 1966). Current salary of Project Assistant in the Electron Microscope, per annum. \$5,500. We urgently need support for 6 months salary. \$2,750.



## UPPER ATMOSPHERE AND EXTRATERRESTIAL RESEARCH

### AN INVESTIGATION OF CHARGE CHANGING REACTIONS BETWEEN IONS AND POLARIZED ATOMS

L. W. Anderson, Professor  
W. Haeberli, Professor  
Department of Physics

We have during the first half of this grant constructed a stainless steel vacuum chamber in which charge changing collisions between atoms and ions can be studied. The chamber is constructed so as to enable us to polarize the atoms before they enter the region where the charge changing collision occurs. Light sources for polarizing atomic cesium by optical pumping have been constructed and tested. The construction of the remaining necessary equipment is now in progress.

Professor Haeberli's group has constructed and tested a scattering chamber to detect the alignment of a fast deuteron beam by using the  $T(d,n) He^4$  reaction.

During the remaining six months of this grant we shall try to test the principle of producing polarized ions by charge changing collisions by attempting to produce fast polarized hydrogen atoms by charge changing collisions of protons and polarized Cs atoms or polarized hydrogen atoms. If this test is successful we shall attempt to study the rf spectroscopy of polarized ions by this technique.

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### TRACE DETERMINATION THROUGH CONTINUOUS ELECTROLYSIS

W. J. Blaedel, Professor  
Department of Chemistry

Deposition of  $Co(II)$  upon a graphite electrode has been investigated for a number of solutions at the  $10^{-4}$  molar level: (ammonia, acetate, oxalate, carbonate, phosphate, sulfate, chloride, and EDTA), and yields over 99% have been obtained for most solutions. Stripping into these various kinds of solutions has also been found to be quantitative.  $Zn(II)$  at  $10^{-4}$  M will be investigated next, and then the concentration level will be lowered to  $10^{-6}$  M.

Two more approaches are being investigated that show promise for trace analysis: (1) An enzyme fixed in a gel layer attached to a platinum microelectrode is sensitive to the substrate in the ambient solution and might be useable as a specific amperometric (i.e., polarographic) sensor for the substrate. Alcohol dehydrogenase will be used to test the procedure. (2) Trace cations will distribute between two

solutions separated by a cation exchange membrane in the ratio of the concentrations of the bulk electrolytes in the two solutions. Thus, cation traces in a natural water sample (at an ionic strength around 0.001 M) should concentrate 100-fold into a solution containing 0.1 M  $\text{NH}_4\text{Cl}$ . This approach is being investigated for separation and concentration of traces.

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#### MAPPING FROM LUNAR PROBE PHOTOGRAPHY

Donald R. Graff, Professor  
James L. Clapp, Professor  
Department of Civil Engineering

35 mm. negative film strips from the Ranger 7, 8, and 9 missions have been obtained from the Jet Propulsion Laboratory. Along with the film strips, the photographic parameters for Ranger 7 and 8 were also obtained. The photo parameters for Ranger 9 will be available at a later date. Selenographic co-ordinates for lunar control, based on earth photography, has been obtained from Army Map Service.

Mr. Wolf is currently investigating a solution for the position of points from two vertical photographs taken at different altitudes with the optical axis of the lens coincident.

It is expected that during the balance of the academic year, the geometry of oblique photographs taken at different altitudes will be investigated and programmed for a computing machine. Some of the exposures from the above-mentioned film strips will be enlarged and topographic mapping will be attempted. The theoretical precision obtainable with this process will be investigated.

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#### EXTENSION AND COMPLETION OF SPECTROSCOPIC STUDIES OF THE ZODIACAL LIGHT

J. E. Mack, Professor  
Department of Physics

We have almost completed the initial phase of this research, which involves the development of a suitable computer program for the reduction of our spectroscopic data to yield true spectral profiles of the zodiacal light. The program constructs a function representing the zodiacal light spectrum in such a way to minimize the error between the

observed signals and the convolution of the constructed function with the known instrumental profile. Various checks are now being made to insure that the program actually performs correctly.

We have not yet begun a comprehensive analysis of our data, awaiting the certainty that the program works as it should. We expect that within a few weeks we will begin a systematic reduction of all the available data, and that when this is completed only a small number of calculations will be required to combine the data and finish the project.

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PHOTOMETRIC OBSERVATIONS OF THE SPECTRAL  
DISTRIBUTION OF AN OBJECT

Robert A. R. Parker, Professor  
Department of Astronomy

The offset guider is at present being constructed by an external contractor for a total cost of \$5,250, of which \$2,000 is being paid by this project and the rest by a separate grant from ARPA. Expected completion time is January 1966.

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HIGH RESOLUTION SPECTROSCOPY OF AIRGLOW  
IN THE EARTH'S ATMOSPHERE

Fred L. Roesler, Professor  
Department of Physics

Work during the first half of the grant period has been limited to a study of the instrumental requirements for making airglow observations with a PEPSIOS spectrometer, and studies directed at finding satisfactory methods for performing the optical alignment under the conditions presented by the day airglow.

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